CLAIMS

1. (Original) An implantable medical device operating in accordance with programming data received over a downlink communications channel established by a modulated RF transmission sent from an external programming unit, comprising:

an electrical stimulation therapy delivery circuit disposed within a hermetically sealed housing adapted for implantation in the body of a patient;

a memory having programming data storage locations accessed by the electrical stimulation therapy delivery circuit;

an RF antenna; and

a telemetry circuit coupled to the RF antenna and having a programming data output accessed by the memory; said telemetry circuit including an out-of-band rejection filter comprising a thin film bulk acoustic resonator filter.

2. (Original) The implantable medical device of claim 1 wherein the electrical stimulation therapy delivery circuit comprises cardiac pacemaker circuitry including a sense amplifier circuit, a stimulating pulse output circuit, a cardiac lead interface circuit coupled to the stimulating pulse output circuit, and a pacing timing and control circuit coupled to the sense amplifier and the stimulating pulse output circuit.

3. (Original) The implantable medical device of claim 1 wherein the out-of-band rejection filter is a bandpass filter.

4. (Original) The implantable medical device of claim 1 wherein the telemetry circuit further includes an amplifier coupled to the thin film bulk acoustic resonator filter and a demodulator coupled to the amplifier; and wherein the thin film bulk acoustic resonator filter, the amplifier and the demodulator are fabricated on a common integrated circuit die.

5. (Original) The implanted medical device of claim 1 wherein the telemetry circuit is a multichannel receiver comprising:

an amplifier coupled to the RF antenna;

a plurality of signal receiving circuits including a bandpass filter and a detector, each filter comprising a thin film bulk acoustic resonator narrowband, bandpass filter having a unique center frequency and constituting a particular receiver channel;

a multiplexing circuit having a separate signal input coupled to each of the signal receiving circuits and a signal output providing access to a selected one of the signal inputs;

an analog-to-digital converter coupled to the output of the multiplexing circuit and accepting a signal originating from the signal receiving circuit that is coupled to the selected multiplexing circuit input, the analog-to-digital converter having a multi-bit digital signal output providing a digitized sample of the accepted signal; and

a processor operating in accordance with a set of program instructions to control the multiplexing circuit in providing sequential access of the analog-to-digital converter to each of the multiplexing circuit signal inputs,

the processor further operating in accordance with the set of program instructions to evaluate the noise level of each channel and to make a selection of one of the channels for further communication with the external programming unit.

6. (Original) The implanted medical device of claim 1 wherein the telemetry circuit is a multichannel receiver comprising:

an RF antenna;

a plurality of thin film bulk acoustic resonator bandpass filters coupled to the RF antenna, each filter having a unique center frequency and defining an individual receiver channel;

a multiplexing circuit coupled to the bandpass filters and having a signal output; and a programming data demodulator coupled to the signal output of the multiplexing circuit.

7. (Original) The implanted medical device of claim 6, wherein the multiplexing circuit has a control input connectable to a storage location within the memory to receive programming data defining selection of one of the bandpass filters for connection to the multiplexing circuit signal output.

8. (Original) An external programming unit for an implantable medical device operating in accordance with programming data received over a downlink communications channel established by a modulated RF transmission sent from the external programming unit and providing device information to the programming unit over an uplink communications channel established by a modulated RF transmission sent from the device, comprising:

a housing carrying a display screen;

a programming head including an RF antenna;

a telemetry circuit disposed within the housing and coupled to the RF antenna, the telemetry circuit including an out-of-band rejection filter comprising a thin film bulk acoustic resonator filter.

9. (Original) The programming unit of claim 8 wherein the telemetry circuit is a multichannel receiver comprising:

an amplifier coupled to the RF antenna;

a plurality of thin film bulk acoustic resonator narrowband, bandpass filters of differing center frequency coupled to the amplifier and defining individual receiver channels;

a multiplexing circuit having a separate signal input coupled to each of the bandpass filters and a signal output providing access to a selected one of the signal inputs;

an analog-to-digital converter coupled to the output of the multiplexing circuit and accepting a signal originating from the bandpass filter that is coupled to the selected multiplexing circuit input, the analog-to-digital converter having a multi-bit digital signal output providing a digitized sample of the bandpass filter signal; and

a processor operating in accordance with a set of program instructions to control the multiplexing circuit in providing access of the analog-to-digital converter to a signal from each of the bandpass filters and to obtain a digitized sample of the signal from each of the bandpass filters,

the processor further operating in accordance with the set of program instructions to evaluate the signal-to-noise ratio of each channel and to make a selection of one of the channels for further communication with the implanted medical device.

10. (Original) A method of downlink telemetry communication from an external programming unit to an implantable medical device, comprising the steps of:

establishing a telemetry link between the external programming unit and the implantable medical device;

transmitting programming data from the external programming unit to the implantable medical device using a modulated RF transmission;

filtering the modulated RF transmission in the implantable medical device using an out-of-band rejection filter comprising a thin film bulk acoustic resonator filter; and

demodulating the filtered RF transmission to obtain the transmitted programming data.

11. (Original) The method of claim 10 wherein the implantable medical device includes one of a cardiac pacemaker, cardioverter, defibrillator, neuro stimulator, drug pump, insertable loop recorder, or physiologic monitor.

12. (Original) The method of claim 10 wherein the filtering step comprises bandpass filtering.

13. (Original) A method of downlink telemetry communication from an external programming unit to an implantable medical device, comprising the steps of:

providing a plurality of out-of-band rejection filters in the implantable medical device, each filter comprising a thin film bulk acoustic resonator filter and each filter being tuned to a one of a plurality of different RF transmission carrier frequency channels;

determining a level of noise on each RF transmission carrier frequency channel;

selecting one of the filters as the preferred data transmission channel for further downlink telemetry communications based upon a determination of the noise level existing on each RF transmission carrier frequency channel;

establishing a telemetry link between the external programming unit and the implantable medical device on the selected RF transmission carrier frequency channel;

transmitting programming data from the external programming unit to the implantable medical device using a modulated RF transmission on the selected RF transmission carrier frequency channels;

applying the modulated RF transmission to the plurality of out-of-band rejection filters in the implantable medical device;

multiplexing signals passed by the out-of-band rejection filters to permit selection of one filter as the preferred data transmission channel; and

demodulating the signals passed by the selected filter to recover the programming data.

14. (Original) The method of claim 13 wherein the implantable medical device is one of a cardiac pacemaker, cardioverter, defibrillator, neuro stimulator, drug pump, insertable loop recorder, or physiologic monitor.

15. (Original) A method of identifying a preferred data transmission channel from among a plurality of different RF transmission frequency channels for downlink telemetry communication from an external programming unit to an implantable medical device, comprising the steps of:

providing a plurality of out-of-band rejection filters in the external programming unit, each filter comprising a thin film bulk acoustic resonator filter and each filter being tuned to a one of a plurality of different RF transmission carrier frequency channels to pass a signal within the passband of the filter;

multiplexing the signals passed by the out-of-band rejection filters;

sequentially accessing each of the multiplexed filter signals;

obtaining a digitized sample of each multiplexed filter signal when accessed;

storing the digitized signal samples;

processing the digitized signal samples to determine the noise level on each channel; and

selecting one of the RF transmission frequency channels as a preferred data transmission channel for downlink telemetry communications sent to the implantable medical device.

16. (Original) The method of claim 15 wherein the implantable medical device is one of a cardiac pacemaker, cardioverter, defibrillator, neuro stimulator, drug pump, insertable loop recorder, or physiologic monitor.

17. (Original) The method of claim 15 wherein the step of processing the stored samples to determine the noise level on each channel comprises making a determination of the signal-to-noise ratio of each channel.

18. (Original) A method of identifying a preferred data transmission channel from among a plurality of different RF transmission frequency channels for downlink telemetry

communication from an external programming unit to an implantable medical device,

comprising the steps of:

applying ambient signals obtained from an antenna to a broadband amplifier;

applying the amplified broadband ambient signals to a plurality of bandpass filters in the programming unit wherein each filter comprises a thin film bulk acoustic resonator filter tuned to pass signals at one of a plurality of different RF transmission frequency channels;

multiplexing signals passed by the filters to permit selection of a signal being passed by a particular one of the filters;

selecting each filter in the programming unit in sequence;

obtaining a digitized sample of the signal passed by each filter when selected;

storing the digitized signal samples; and

processing the digitized signal samples obtained for each channel to determine the noise level on each channel; and

selecting one of the RF transmission frequency channels for downlink telemetry communications sent to the implantable medical device.